



**ELASTO-CUSHION TRUCK
PERFORMANCE STUDY
TP 3823 E**

**R. Gonsalves
W. Pak
G. Izbinsky**

**Department of Research
Canadian Pacific Ltd.
Report No. S714-82
October, 1982**

**Prepared for:
Transport Canada
Transportation Development Centre**

**ing
of.
s
r
ess**

The contents of the report reflect the views of the contractor and not necessarily the official views or policies of the Transportation Development Centre of Transport Canada.

REPORT DOCUMENTATION FORM

1. Transport Canada Report No. TP 3823 E	2. TDC Project No. 4829	3. Recipient's Catalogue No.	
4. Title and Subtitle Elasto-Cushion Truck Performance Study		5. Report Date October 1982	
		6. Performing Organization Report No. S714-82	
7. Author(s) R. Gonsalves W. Pak G. Izbinsky		8. Transport Canada File No. D 1465-108-7-5	
9. Performing Organization Name and Address Department of Research Canadian Pacific Limited Windsor Station Montreal, Quebec H3C 3E4		10. DSS File No. 09SD T8200-0-0532	
		11. DSS or Transport Canada Contract No. OSD81-00006	
12. Sponsoring Agency Name and Address Transportation Development Centre (TDC) 1000 Sherbrooke Street West P.O. Box 549, Place de l'Aviation Montreal, Quebec H3A 2R3		13. Type of Report and Period Covered Technical	
		14. Sponsoring Agency Code TDC 4289	
15. Supplementary Notes Canadian Pacific Limited and TDC equally shared the cost of the program.		16. TDC Project Officer D.W. Dibble	
17. Abstract Curving performance and hunting tests were carried out to determine the behaviour of conventional 3-piece trucks with new CN 'A' profile wheels, modified by utilizing elastomeric shear pads between the bearing adapter and the side frame pedestal roof. Field test results on a 5-degree curve with measurement of lateral/vertical forces and angle-of-attack indicated that the full benefit of natural wheelset steering was not obtained due to parallelogramming of the truck at below balance speeds for the curve. Hunting tests conducted with elastomeric pads of a lower shear stiffness (15,000 lbs/in) showed that the intermittent hunting commenced at 65 mph.			
18. Key Words Curving and hunting tests, conventional 3-piece trucks, elastomeric shear pads, lateral/vertical forces, angle-of-attack.		19. Distribution Statement Copies available from TDC.	
20. Security Classification (of this report) NIL	21. Security Classification (of this page) NIL	22. No. of Pages	23. Price -

FORMULE DE DOCUMENTATION POUR RAPPORT

1. N° du rapport Transports Canada TP 3823 E	2. N° de l'étude — CDT 4829	3. N° de catalogue du destinataire	
4. Titre et sous-titre Elasto-Cushion Truck Performance Study		5. Date du rapport Octobre 1982	
		6. N° du rapport de l'organisme exécutant S714-82	
7. Auteur(s) R. Gonsalves W. Pak G. Isbinsky		8. N° de dossier Transports Canada D-1465-108-7-5	
9. Nom et adresse de l'organisme exécutant Canadien Pacifique Ltée Gare Windsor Montréal, Québec H3C 3E4		10. N° de dossier — ASC 09SD - T8200-0-0532	
		11. N° de contrat — ASC ou Transports Canada OSD81-00006	
12. Nom et adresse de l'organisme parrain Centre de Développement des Transports (CDT) 1000 ouest, rue Sherbrooke B.P. 549, Place de l'aviation Montréal, Québec H3A 2R3		13. Genre de rapport et période visée Technique	
		14. Code de l'organisme parrain CDT-4289	
15. Remarques additionnelles Le CP et le CDT se sont partagés les frais		16. Agent de projet — CDT D.W. Dibble	
17. Résumé Des essais sur le phénomène de lacet et sur les inscriptions en courbe ont été faits pour étudier le comportement des bogies standard à 3 essieux, modifiés par l'adjonction de tampons en caoutchouc synthétique entre l'adaptateur élastique et le sommet de la plaque de garde du châssis latéral du bogie. Ces essieux étaient équipés de roues neuves à profil CN 'A'. Ces essais, complétés par la mesure des forces transversales et latérales et de l'angle d'inscription, ont montré que l'inscription en courbe de 5° à une vitesse inférieure à celle d'équilibre, entraînait la déformation du bogie directeur, empêchant les essieux de tirer le plein parti de ce type de roues. Les essais sur le phénomène de lacet ont montré que, lorsque les tampons caoutchouc avaient une raideur en cisaillement de 15 000 lb par pouce seulement, un phénomène de lacet intermittent se manifestait quand la vitesse atteignait 65mi/h.			
18. Mots-clés Essais d'inscription dans les courbes et lacet. Bogies standard à 3 essieux Tampons caoutchouc synthétique. Forces transversales et verticales. Angle d'ins-		19. Diffusion Disponibilité d'exemplaire en nombre limité au CDT	
20. Classification de sécurité (de ce rapport) NIL	21. Classification de sécurité (de cette page) NIL	22. Nombre de pages	23. Prix -

Acknowledgements

The Research Department acknowledges the contribution of personnel from the following organizations.

- Office of the Chief Mechanical Officer for assistance during the course of this test program.
- The National Research Council of Canada, Railway Laboratory, Division of Mechanical Engineering for their contribution to the field work.
- Officers and personnel of the Calgary Division, Alberta South Division and Ogden Shops for assistance during the tests.
- Transportation Development Centre, Transport Canada for financial support under contract # OSD81-00006.

EXECUTIVE SUMMARY

A series of hunting and curving performance tests was conducted in the Fall of 1981 to study the behaviour of conventional 3-piece trucks modified by the insertion of elastomeric shear pads between the bearing adaptor and the side frame pedestal roof. The test cars with modified trucks and the reference car trucks were all equipped with new CN 'A' profile wheels.

Field test results indicate that the curving performance of elasto-cushion trucks is similar to radial trucks at or above the balance speed on a 5 degree curve. Below balance speed, however, the leading truck tended to parallelogram, and hence the full benefit from natural wheelset steering was not obtained.

The hunting tests indicate that the lateral stability of elasto-cushion trucks with shear pads of 21,000 lbs/in shear stiffness did not differ from conventional 3-piece trucks as tested with the experimental CN 'A' profile wheels. However, when pads with lower shear stiffness (15,000 lbs/in) were introduced, intermittent hunting occurred at 65 mph.

SOMMAIRE

Des essais sur le phénomène de lacet et sur les inscriptions en courbe ont été faits à l'automne de 1981 pour étudier le comportement des bogies standard à 3 essieux, modifiées par l'adjonction de tampons en caoutchouc synthétique entre l'adaptateur élastique et le sommet de la plaque de garde du châssis latéral du bogie. Les wagons d'essai équipés de ces bogies de même que les wagons témoins avaient des roues à profil CN 'A' neuves.

Les essais ont montré qu'à l'inscription, dans une courbe de 5° , la tenue des bogies standard ainsi modifiées était comparable à celle des bogies articulés lorsque la vitesse était égale ou supérieure à celle d'équilibre. Cependant, au-dessous de cette vitesse, la déformation du bogie directeur qui en résultait empêchait les essieux de tirer le plein parti de ce type de roues.

Les essais sur le phénomène de lacet ont montré que la stabilité latérale des bogies équipés de tampons caoutchouc d'une raideur en cisaillement de 21 000 lb par pouce ne diffèrait pas de celle des bogies standard équipés comme ils l'étaient de roues neuves à profil CN 'A'. Toutefois, quand ces tampons étaient remplacés par d'autres ayant une raideur en cisaillement de 15 000 lb par pouce seulement, un phénomène de lacet intermittent se manifestait lorsque la vitesse atteignait 65 mi/h.

TABLE OF CONTENTS

	<u>Page</u>
1. INTRODUCTION	1
2. CURVING PERFORMANCE TESTS AND ANALYSIS OF ELASTO-CUSHION TRUCKS	2
2.1 Instrumentation and Test Site	2
2.2 Test Consist and Procedure	2
2.3 Discussion of Test Results	3
2.4 Theoretical Analysis	4
2.5 Conclusions	5
3. HUNTING STABILITY TESTS AND ANALYSIS OF ELASTO-CUSHION TRUCKS	6
3.1 Test Site	6
3.2 Instrumentation	6
3.3 Test Consist	6
3.4 Data Analysis	7
3.5 Discussion of Test Results	8
3.6 Conclusions	9
4. REFERENCES	10

LIST OF ILLUSTRATIONS

<u>Number</u>	<u>Description</u>	<u>Page</u>
1	Angle-of-attack and rail forces at different curving speeds with 21,000 lbs/in shear pad (eastbound, unwyed)	11
2	Angle-of-attack and rail forces at different curving speeds with 21,000 lbs/in shear pad (westbound, wyed)	12
3	Angle-of-attack and rail forces at different curving speeds with 15,000 lbs/in shear pad (westbound, unwyed)	13
4	Angle-of-attack and rail forces at different curving speeds with 15,000 lbs/in shear pad (eastbound, unwyed)	14
5	Angle-of-attack and rail forces at different curving speeds with 15,000 lbs/in shear pad (westbound, wyed)	15
6	Lateral acceleration on trailing truck lead axle bearing end cap vs speed for trucks with CN 'A' profile wheels	16
7	Lateral acceleration of car body at the trailing truck vs speed for trucks with CN 'A' profile wheels	17
8	Lateral acceleration of car body at the trailing truck vs speed for trucks with CN 'A' profile wheels	18
9	Lateral acceleration of car body at the trailing truck vs speed for trucks with CN 'A' profile wheels	19
10	Predominant lateral wheelset and car body frequency vs speed for the conventional Barber S2 truck with LC pads and CN 'A' profile wheels.	20

1. INTRODUCTION

Previous research has been conducted on a conventional three-piece freight car truck which had been modified by the insertion of a rubber shear pad (Elastomeric LC-Pad manufactured by Lord Kinematics) at the pedestal roof bearing adaptor interface. Field tests using instrumented wheelsets with these modified trucks indicated that there was a reduction in lateral wheel/rail forces on curves (Ref. 1). As a result, certain railways have since adopted this modification as standard on their freight car trucks. Subsequent service experience further indicated that there is a noticeable flange wear reduction compared with conventional unmodified trucks. However, no angle-of-attack measurements were ever made on these trucks, and hence the steering characteristics of these trucks were not fully investigated.

From previous testing (Ref. 2) conducted by CP Research, it was recognized that the horizontal suspension of a conventional 3-piece freight car truck is characterized by very high interaxle yaw stiffness and low interaxle shear stiffness. Hence in steady state curving, while the axles are kept parallel they tend to parallelogram relative to each other. This results in an increase in the angle-of-attack of the leading flanging wheel, thus causing heavy flange wear during curving.

Introducing LC-pads in the truck side frame pedestal roof area would allow the axles to yaw relative to each other and, therefore, utilize the benefit of longitudinal steering moments naturally generated at the wheel/rail interface, to reduce the angle-of-attack. However, introducing LC-pads also reduces the parallelogramming stiffness of a 3-piece truck, and thus compromises to a certain degree the benefits derived from wheelset steering. A clear understanding of the aforementioned trade off in curving behaviour is desirable before truck modifications are undertaken to improve curving performance.

Reducing the interaxle shear stiffness as well as the interaxle yaw stiffness by using LC-pads also affects the lateral stability of 3-piece trucks. According to linear hunting analysis, the stability threshold

is lowered as interaxle shear stiffness is reduced from its nominal value in a 3-piece truck. Therefore, it is important to determine the hunting sensitivity of the truck to a reduction in its interaxle shear stiffness.

In view of the evidence of flange wear reduction experienced by other railways utilizing elasto-cushion trucks, curving and hunting tests as well as theoretical studies on this modified 3-piece truck were conducted in 1981 by CP Research to provide a better understanding of truck behaviour.

2. CURVING PERFORMANCE TESTS AND ANALYSIS OF ELASTO-CUSHION TRUCKS

2.1 Instrumentation and Test Site

Strain-gauges were installed on a 5 degree curve to measure lateral and vertical forces at both rails, as well as wheelset angle-of-attack as the test consist passed the instrumented site at various speeds. Data recorded were processed to generate a lateral/vertical wheel load distribution pattern for each truck and the lateral slippage (angle-of-attack) experienced by each wheelset. Instrumentation for this test was the same as used previously, details of which can be found in Reference 2.

The instrumented test section was located near Calgary at Mileage 12.4 on the Laggan Subdivision. The rail used in this curve consisted of Algoma 1971 RE 132 Lb., 78 ft. staggered jointed rail. The curve had an 0.5% ascending grade in the Westward direction, a superelevation of 4.5" and a corresponding equilibrium speed of 37 mph. The rail flange lubricator was shut off during the tests.

2.2 Test Consist and Procedure

Two series of curving tests were conducted on two different days. The consist in both days was comprised of three 6-axle locomotives, four laden 100-ton bathtub coal cars with Barber S-2 heavy duty trucks in the following sequence; Car 1: Barber S-2 trucks without modification, Car 2: Barber S-2 trucks with C-PEP, Car 3: Barber S-2 trucks with

LC-pads, and Car 4: Barber S-2 trucks with both C-PEP and LC-pads. Both curving tests were conducted with new CN experimental "A" profile wheels. Centre plate of each test truck was well lubricated.

The first tests (Oct. 15) were run with modified trucks equipped with LC-pads of 21,000 lb/in shear stiffness and the second tests (Oct. 17) were conducted with the trucks equipped with LC-pads of 15,000 lb/in shear stiffness. During each series of tests, three runs were made through the test curve in each direction at approximately 25, 37, 45 mph respectively. The test consist was wyed and this procedure repeated for a total of 36 runs. The consist was allowed to coast through the instrumented section of the curve during each test.

2.3 Discussion of Test Results

In order to present the complete curving characteristic of each truck, and to permit correlation between wheel rail forces and angle-of-attack for each wheel, the measured parameters for each test run are presented in one illustration (Fig. 1 to Fig. 5). In these illustrations, the same axle number always indicates the same axle on each truck, whether the consist is wyed or unwyed, moving Eastbound or Westbound. The sign conventions adopted in this report are that positive angle-of-attack signifies axles rolling towards outside of the curve (away from centre), and positive low rail and high rail forces are directed away from the centre of the curve.

From the plotted results, one can observe the general phenomena of reduction of angle-of-attack with increased curving speeds and an increase in angle-of-attack with higher lateral force on low rail. The centrifugal force and the weight transfer effect on vertical wheel loads within each truck due to the moment generated by interaxle shear forces and the net wheel/rail lateral force on each axle are evident. A similar coupling effect between leading and trailing trucks can also be observed. These effects have been discussed in detail in previous reports (Ref. 2).

Comparing the angle-of-attack of the elasto-cushion truck with those of conventional trucks, one can see that there is a marked reduction of angle-of-attack at the leading axle, as a result of wheelset steering. However, at less than balance speed, the leading truck of the cars with LC-pads have a tendency to parallelogram, thus increasing the angle-of-attack at both the leading and trailing axle of the leading truck and hence compromise the benefits of wheelset steering. Maximum lateral and vertical forces do not differ significantly between modified and unmodified trucks, although the lateral creep forces at the low rail are slightly lower at the leading axles of the modified trucks, due to angle-of-attack reduction when steering.

The modified trucks with softer LC-pads of lower shear stiffness (15,000 lbs/in) steers slightly better than those with stiffer LC-pads (21,000 lbs/in). However, the parallelogramming action is also more severe with LC-pads of lower shear stiffness for the leading truck below the balance speed.

From these Figures, it was also observed that the parallelogramming action on the leading truck at less than balance speed does not occur exclusively on modified trucks. Conventional trucks also possess this tendency, but to a lesser extent, as compared to the modified trucks.

2.4 Theoretical Analysis

In order to provide a theoretical explanation of the lead truck parallelogramming observed at less than balance speed on elasto-cushion trucks, computer simulations were conducted utilizing a non-linear steady-state curving model recently developed by CP Research (Ref. 3). Various computer runs were made to simulate elasto-cushion truck behaviour in response to cant deficiency and centre-plate torque. The interaxle yaw stiffness of the truck was kept constant and was computed from the 15,000 lbs/in shear stiffness of the LC pads, and the interaxle shear stiffness was allowed to vary, in order to study truck response as this parameter was lowered from nominal values of 4,000 lb_f/in.

The results indicate that as the parallelogramming stiffness is allowed to decrease keeping the interaxle yaw stiffness constant, the truck curving behaviour becomes more sensitive to centre-plate torque generated from truck bolster rotation experienced during curve entrance. Since bolsters rotate in opposite directions with respect to the car body on curves, the orientation of the centre-plate torque is also opposite in direction for leading and trailing trucks. From these computer simulations, it was concluded that the positive torque experienced on the leading truck tends to parallelogram the truck, while the negative torque experienced on the trailing truck tends to suppress this action.

2.5 Conclusions

1. Elasto-cushion trucks' curving performance is very similar to a radial truck at or above balance speed on a 5 degree curve. At less than balance speed, the lead truck tends to parallelogram, thus compromising the benefits from wheelset steering.
2. Since most radial trucks designed are essentially elasto-cushioned trucks with added cross-members or steering arms, in the event of failure of these interaxle linkage due to fatigue or damage, the curving performance of these trucks would be similar to that documented in the present report for elasto-cushion trucks.

3. HUNTING TESTS AND ANALYSIS OF ELASTO-CUSHION TRUCKS

3.1 Test Site

High speed stability tests were carried out on the Brooks Subdivision east of Calgary between Mileage 160-158. The two mile test zone consisted of tangent track with continuous welded 115 lb/yard rail in 1440 foot lengths laid in 1977.

3.2 Instrumentation

The four test cars were instrumented with accelerometers on the truck and car body to determine wheelset and car body lateral acceleration. The accelerometers on the lead axles of the trailing trucks of the test cars were mounted at the end of the axles on specially designed bearing end caps. The accelerometers on the car body were mounted on the stub sill near the centre plate of the trailing trucks.

Three video cameras were used on the two test cars with LC-pads. One video camera was mounted under the tub of each car body to observe wheelset lateral oscillation, while the other camera was mounted on one car and "angled in" to observe the pedestal/bearing adaptor interface.

The speed of the test cars during each test run were continuously monitored on the instrumentation car. Acceleration signal data was recorded on a 14 channel Phillips FM tape recorder on the instrumentation car.

3.3 Test Consist

The test consist was made up of one 3300 HP MLW locomotive, four empty 100-ton bathtub coal test cars, Dynamometer Car CP 62 (the instrumentation car to record the data) and a crew caboose. Two of the four test cars were fitted with LC pads between the bearing adapter and pedestal roof. One of the two cars with LC-pads had C-PEP. One of the other two

cars with conventional trucks, was equipped with C-PEP. All four test cars were tested with new CN 'A' profile wheels, in order to generate similar wheel rail contact condition.

Two series of tests were carried out. The first test was carried out with LC-pads of 15,000 lb/in shear stiffness and the second test with LC-pads of 21,000 lb/in shear stiffness. A gradual in-step increase in the test car consist speed in 5 mph increments from 40 to 70 mph was carried out for each of the tests. In each case, the required test speed was attained prior to reaching the test zone (Mileage 160-158) and held constant throughout the two mile section for data collection. All tests were run in the same direction over the 2 mile test zone.

3.4 Data Analysis

The high speed lateral accelerometer data recorded during the tests was processed by the National Research Council Railway Laboratory using a Hewlett-Packard, Model 5420A Digital Signal Analyzer.

A power spectral density (psd) analysis of the data was carried out to determine if hunting did occur. The data was analyzed over a bandwidth up to 30 Hz with a resolution of .125 Hz. For both series of tests the signal was analyzed over the same section of track for each test run to avoid any difference of track input to the various test cars.

The outputs of the psd analysis are in the form of plots of signal power normalized to a 1 Hz bandwidth against frequency in units of g^2/Hz ($g = 32.2 \text{ ft/sec}^2$). From the psd analysis the average lateral accelerations (rms 'g') within the bandwidth 1 to 5 Hz were calculated for all the test runs. The rms 'g' values were calculated for the frequency range 1-5 Hz to include the hunting frequency and avoid frequencies unrelated to wheelset oscillation. Similar sample outputs can be seen in the previous report (Ref. 2).

Truck hunting occurs when a sharp increase in the rms lateral acceleration values is observed between one test speed and the next. However, since

the rms 'g' value is an average value, and if hunting was intermittent, the increase in rms 'g' from one test speed to the next will not be so pronounced.

3.5 Discussion of Test Results

Figures 6 to 9 illustrate the rms lateral acceleration on the wheelsets and carbody for the test cars during two days of testing utilizing LC-pads of different shear stiffnesses.

The test results indicate that the conventional Barber S-2 truck with C-PEP and the one without C-PEP, both used as the reference cars, showed a slight difference in rms 'g' values during the two days of testing for speeds above 55 mph. This may have been due to environmental test conditions not being exactly similar on both days of testing. On both days of testing, trucks of both reference cars were stable throughout the test speed range of 40 to 70 mph. The car equipped with C-PEP had a lower average lateral acceleration (rms 'g') as compared to the car without C-PEP.

From the graphs plotted, it can be seen that for the modified trucks with LC-pads of 21,000 lb/in shear stiffness the average lateral acceleration (rms 'g') was the same as for the conventional trucks. However, with LC-pads of a lower shear stiffness of 15,000 lb/in intermittent truck hunting commenced at 65 mph. The intermittent truck hunting which could have been caused by local track irregularities showed no signs of being sustained in the two mile test zone. With LC-pads of a lower shear stiffness (15,000 lb/in) the car body lateral acceleration values (rms 'g') were slightly higher than those from the axle. This would be due to the introduction of a softer primary suspension (LC-pads) which allows the wheelset freedom to move independently of the car body. Even though the lateral acceleration values (rms 'g') were slightly higher on the car body with the LC-pads of lower shear stiffness there were no signs of violent car body hunting to a maximum test speed of 70 mph.

Figure 10 illustrates how the predominant wheelset frequency varies with speed on the lead axles of the leading and trailing truck for the conventional Barber S-2 truck with LC pads of 15,000 lb/in shear stiffness. It was found that the frequency of oscillation of the two trucks and car body were the same up to 60 mph.

3.6 Conclusions

1. Test cars with conventional Barber S-2 trucks equipped with LC-pads of 21,000 lb/in shear stiffness and CN 'A' profile wheels exhibited the same lateral ride of the carbody and trucks up to a maximum speed of 70 mph when compared to the reference cars with conventional Barber S-2 trucks and new CN 'A' profile wheels. The test results were similar whether cars were equipped with C-PEP or not.
2. With LC pads of 15,000 lb/in shear stiffness on the conventional Barber S-2 trucks with CN 'A' profile wheels intermittent truck hunting commenced at 65 mph on the cars with C-PEP as well as without C-PEP.

4. REFERENCES

1. L.W. Peterson Measurement and Analysis of Wheel-Rail
W.H. Freeman Forces.
J.M. Wandrisco ASME paper 71-WA/RT-4
2. R. Gonsalves Railroad Dynamics Incorporated
W. Pak (RDI) Truck Evaluation Test
G. Izbinsky CP report No. S670-81, March 1981,
Transport Canada report No. TP 2970.
3. W. Pak Theoretical Curving Performance of Four
G. Rosval Freight Car Trucks
CP report No. S712-82, December 1981,
Transport Canada report No. TP 3449.

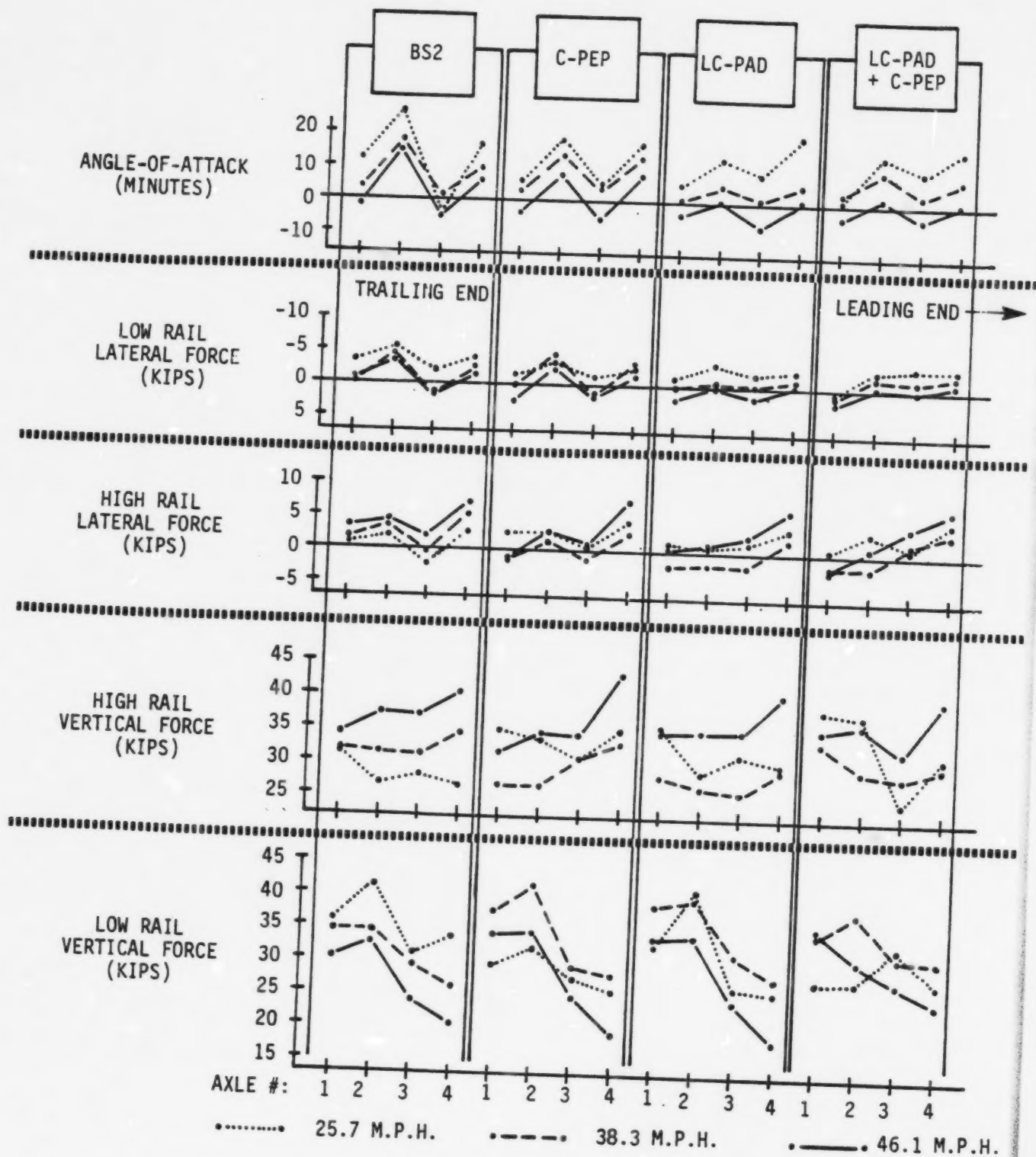


FIG: 1

ANGLE-OF-ATTACK AND RAIL FORCES AT DIFFERENT CURVING SPEEDS
WITH 21,000 lbs/in SHEAR PAD (eastbound, unwyed)

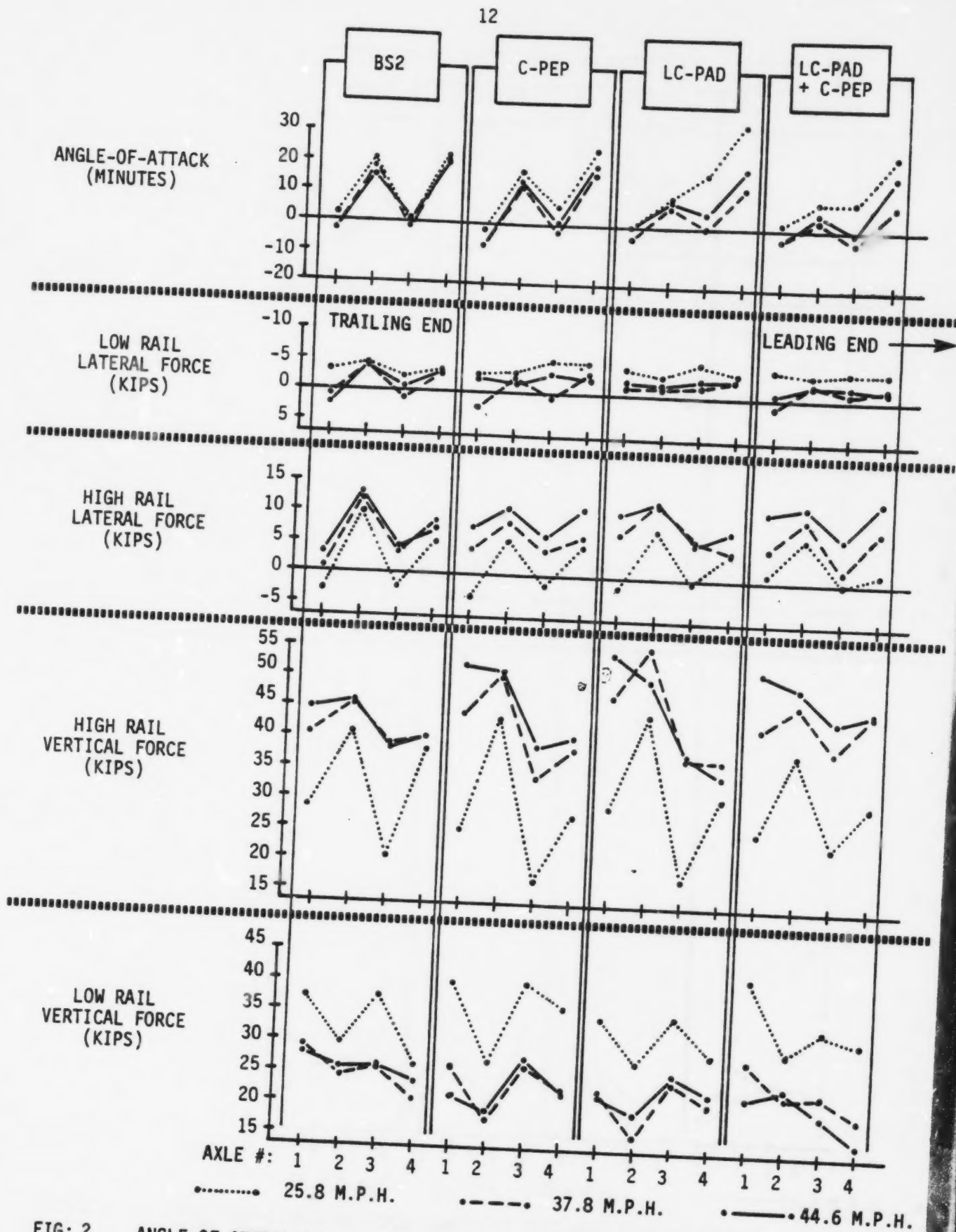


FIG: 2 ANGLE-OF-ATTACK AND RAIL FORCES AT DIFFERENT SPEEDS WITH 21,000 lbs/in SHEAR PAD (westbound, wyed)

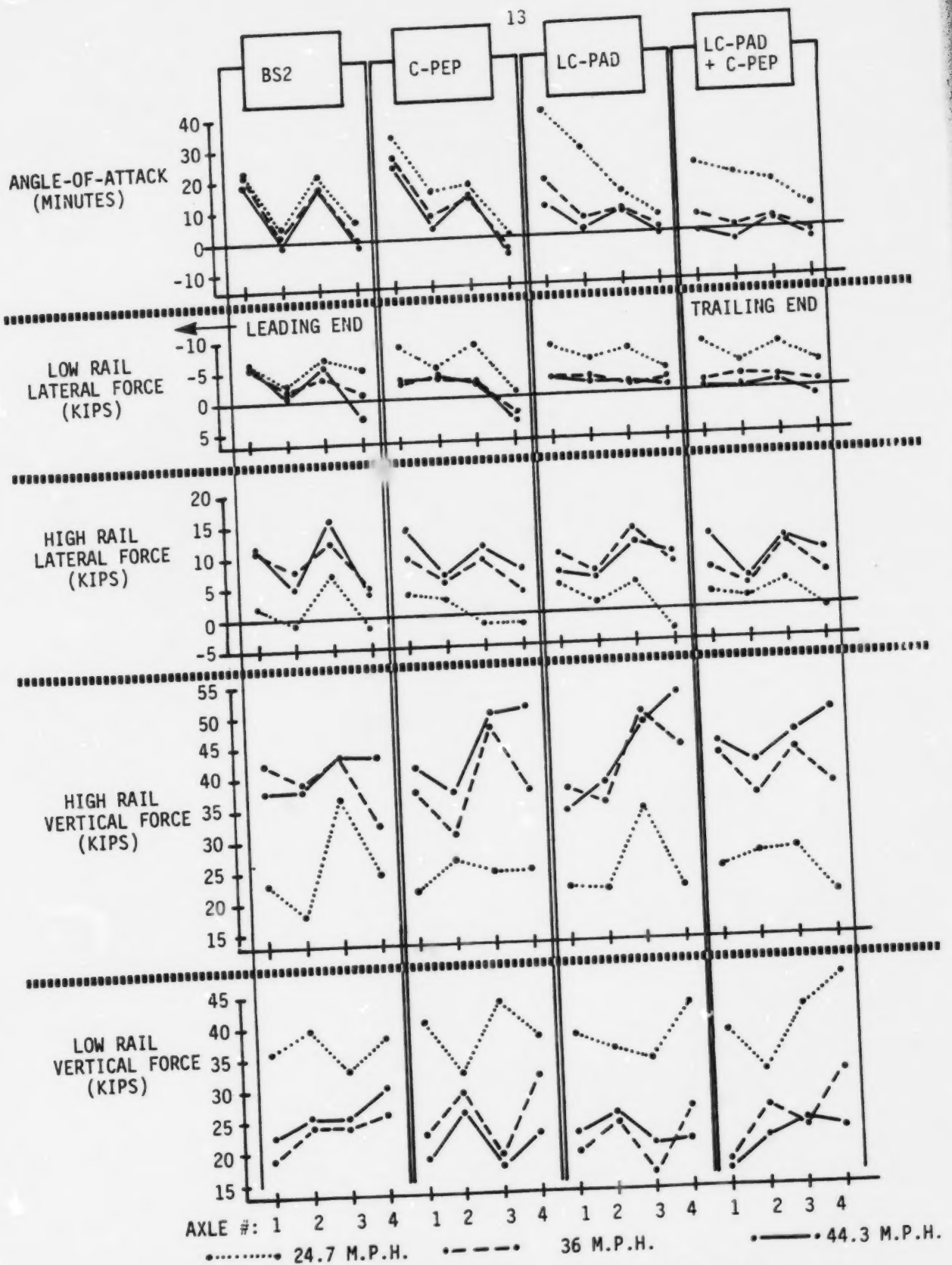


FIG: 3

ANGLE-OF-ATTACK AND RAIL FORCES AT DIFFERENT CURVING SPEEDS
WITH 15,000 lbs/in SHEAR PAD
(westbound, unwyed)

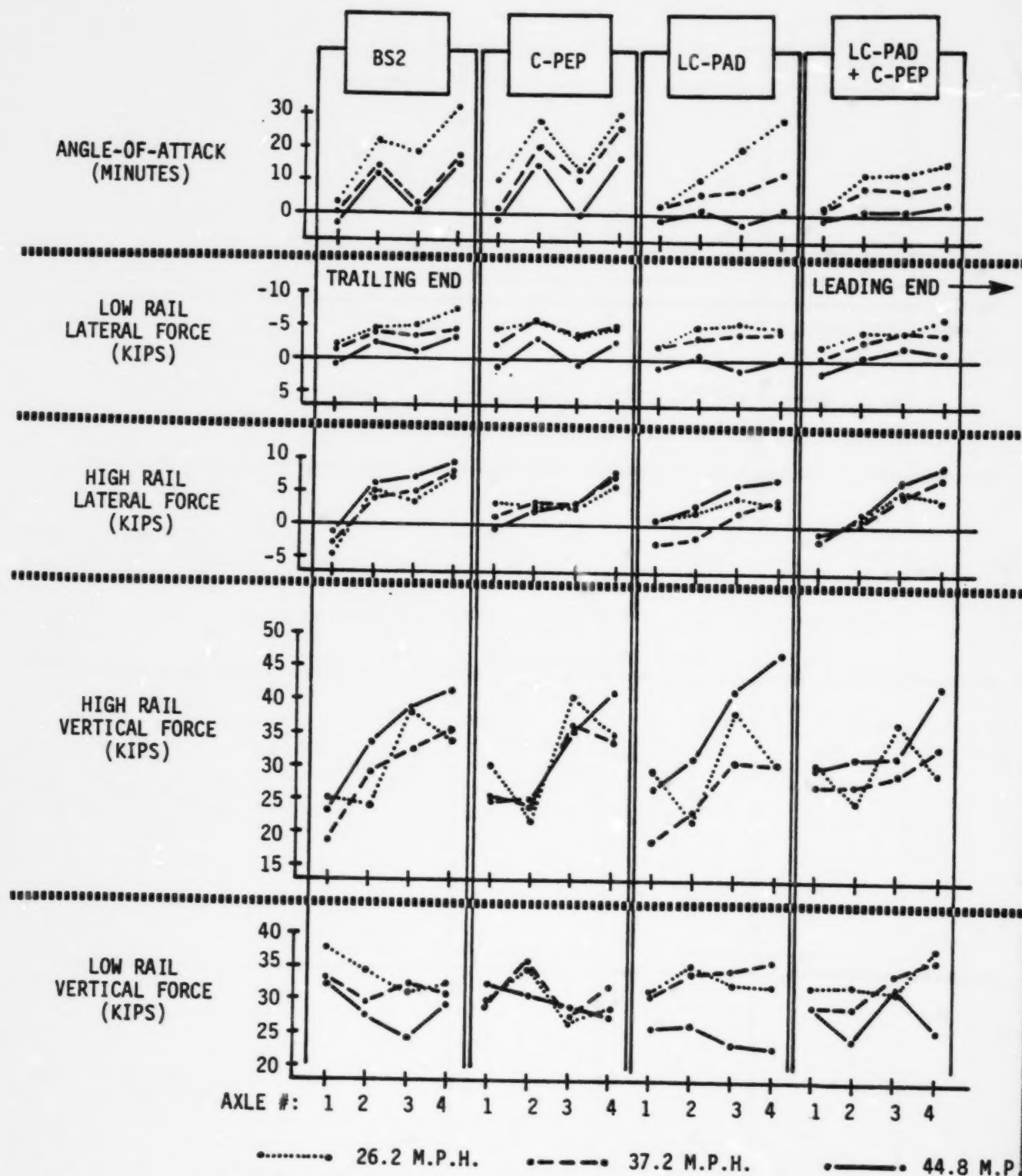


FIG: 4

ANGLE-OF-ATTACK AND RAIL FORCES AT DIFFERENT CURVING SPEEDS WITH 15,000 lbs/in SHEAR PAD (eastbound, unwyed)

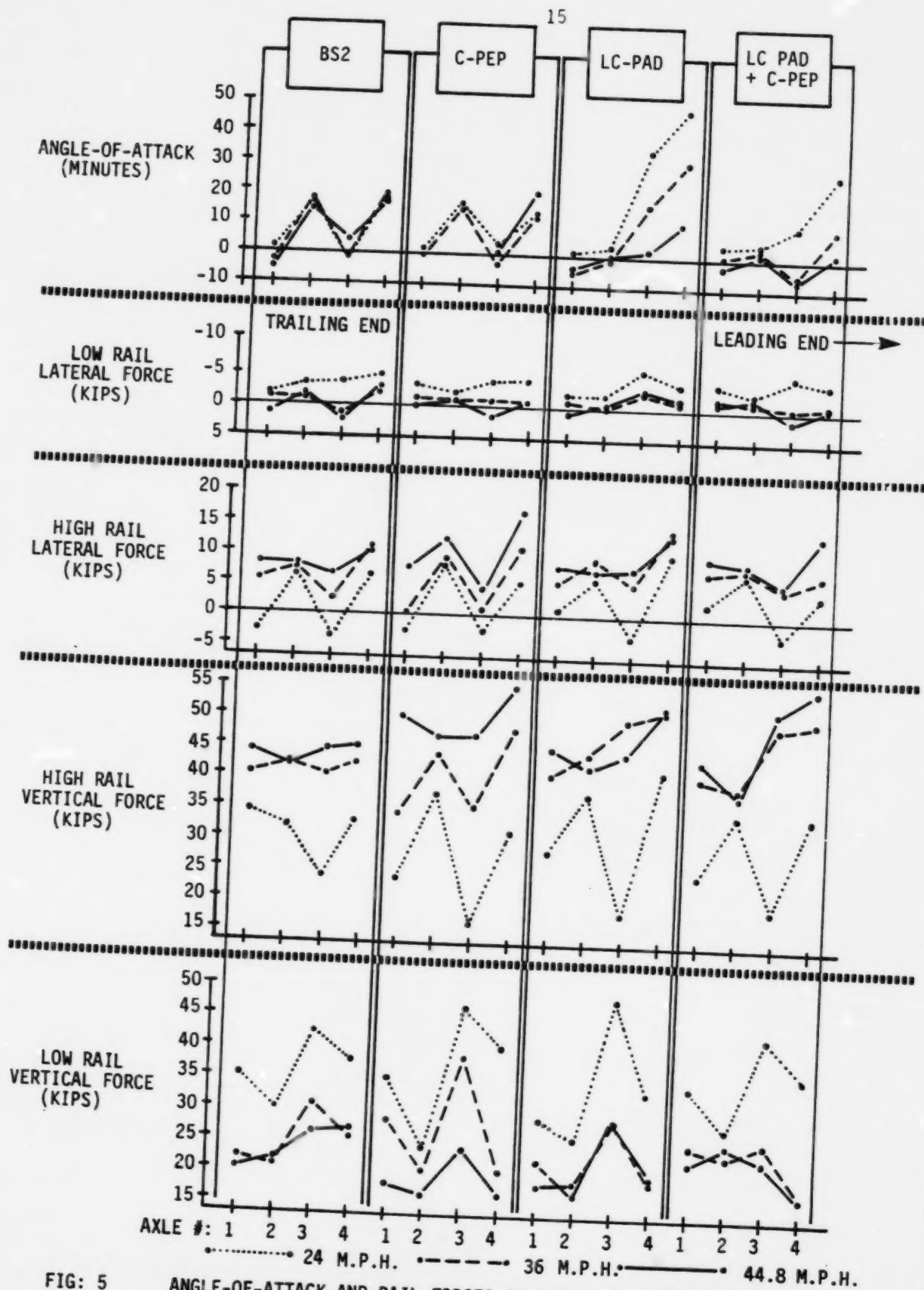


FIG: 5

ANGLE-OF-ATTACK AND RAIL FORCES AT DIFFERENT CURVING SPEEDS
WITH 15,000 lbs/in SHEAR PAD (westbound, wyed)

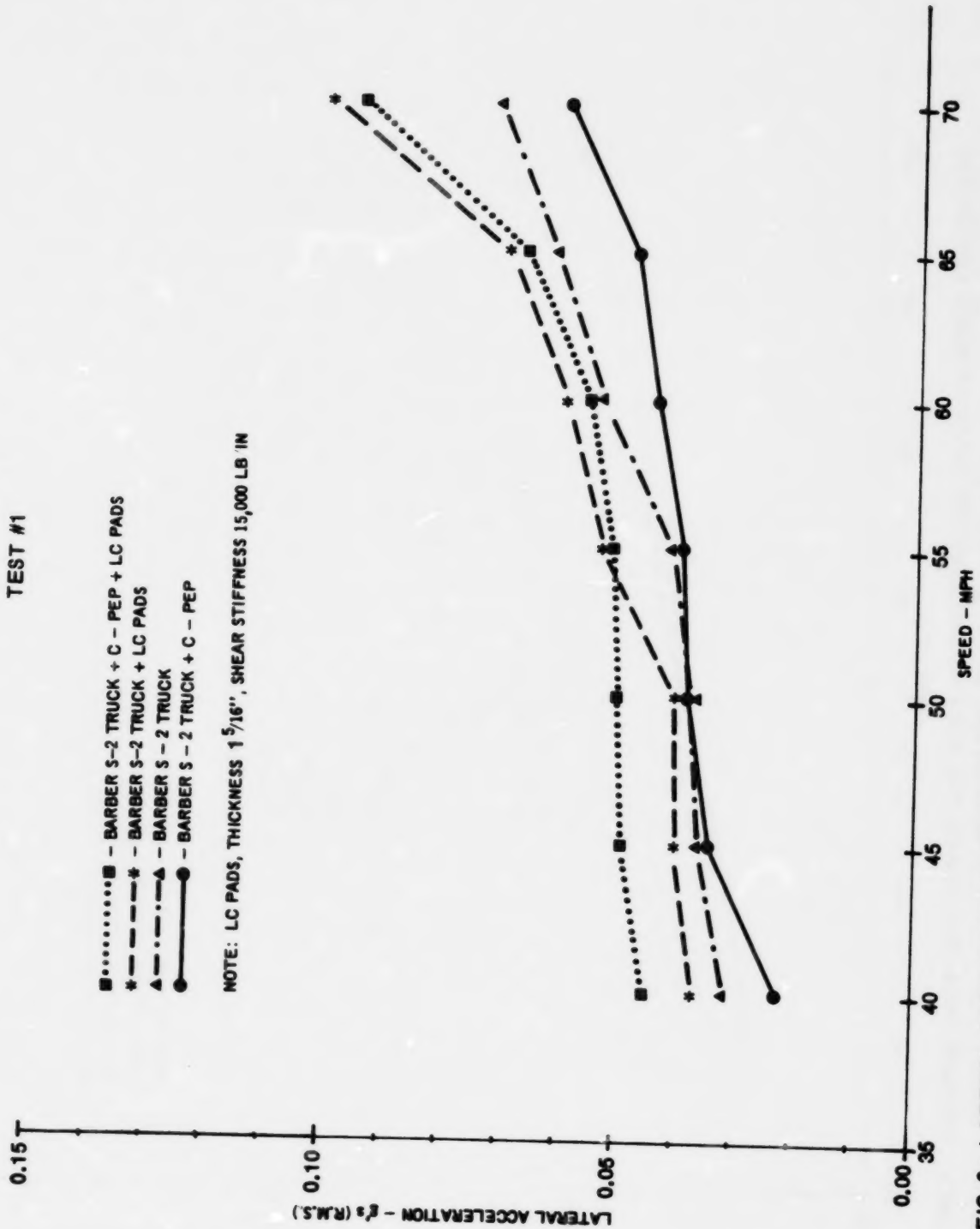


FIG. 8: LATERAL ACCELERATION ON TRAILING TRUCK LEAD AXLE BEARING END CAP VS SPEED FOR TRUCKS WITH CN "A" PROFILE WHEELS

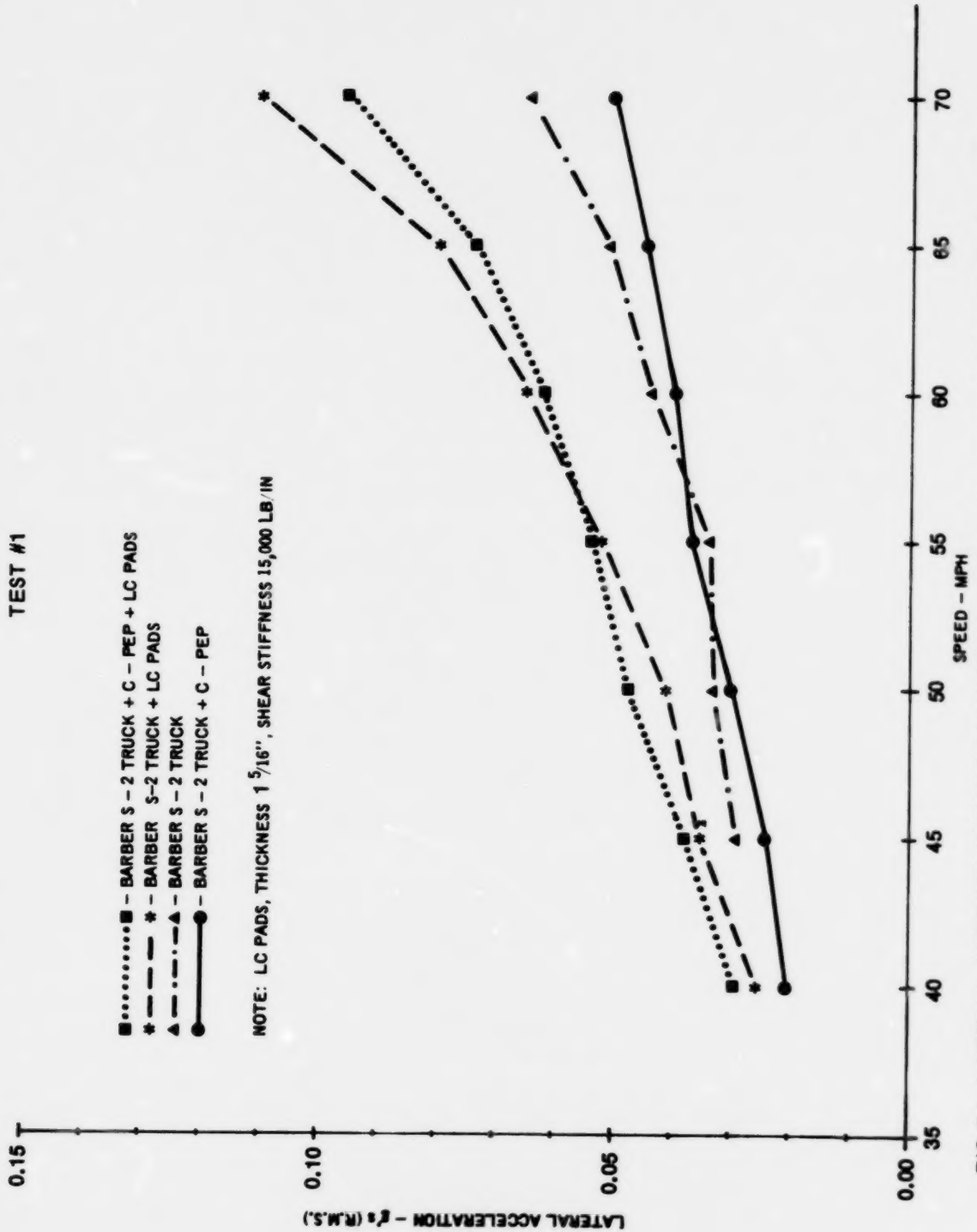


FIG.7: LATERAL ACCELERATION OF CAR BODY AT THE TRAILING TRUCK VS SPEED FOR TRUCKS WITH CN "A" PROFILE WHEELS

TEST #2

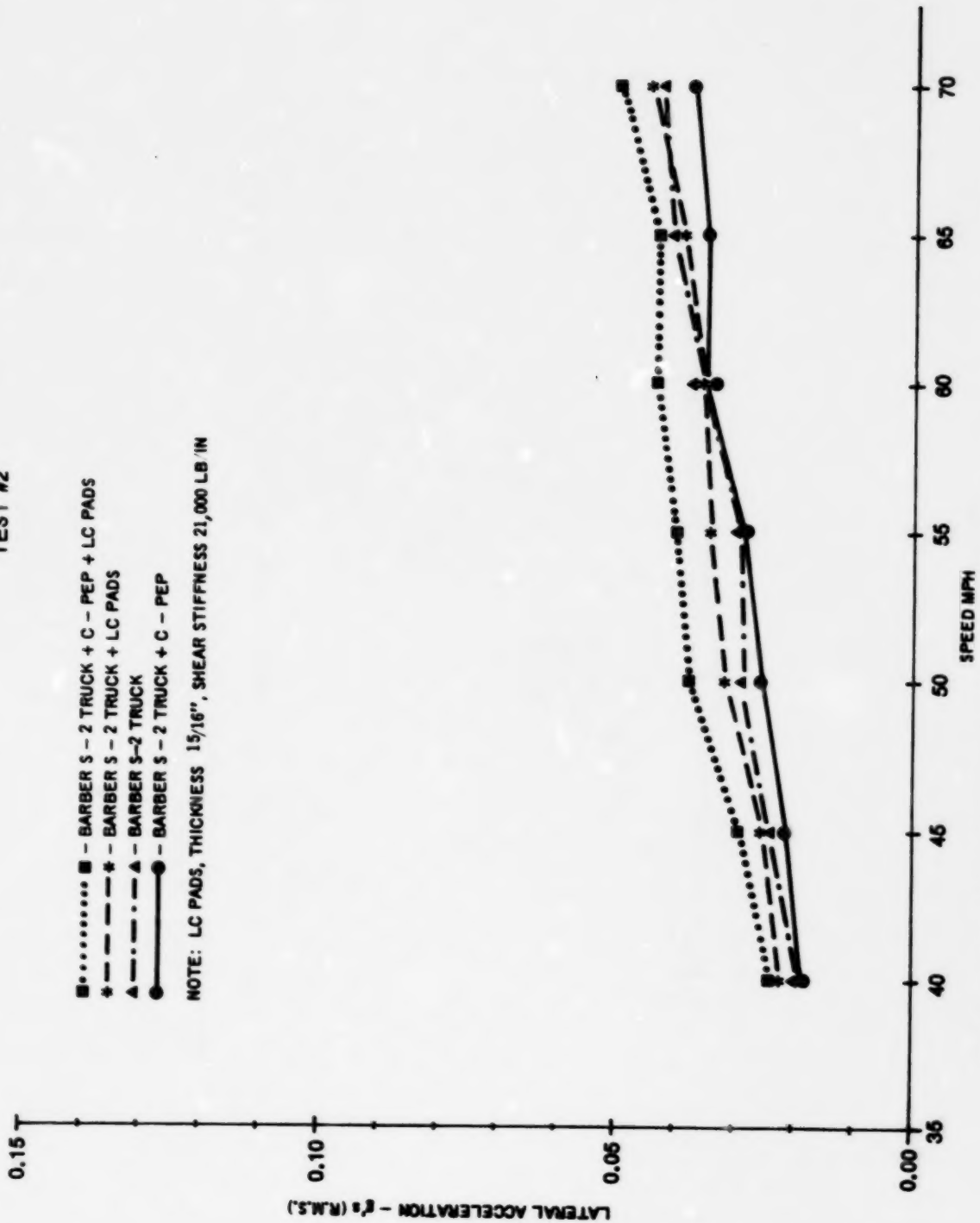


FIG. 8: LATERAL ACCELERATION OF CAR BODY AT THE TRAILING TRUCK VS SPEED
FOR TRUCKS WITH CN "A" PROFILE WHEELS

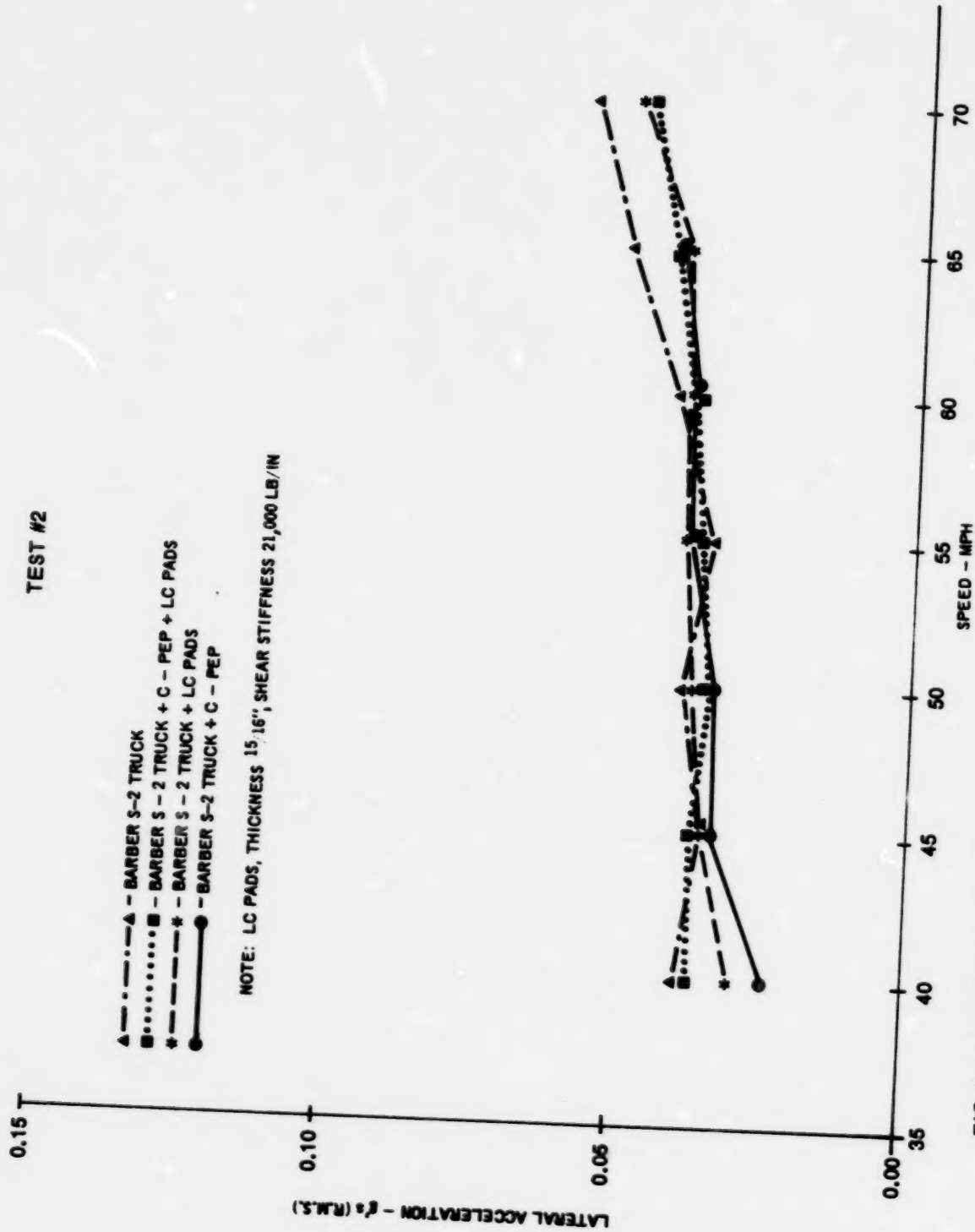
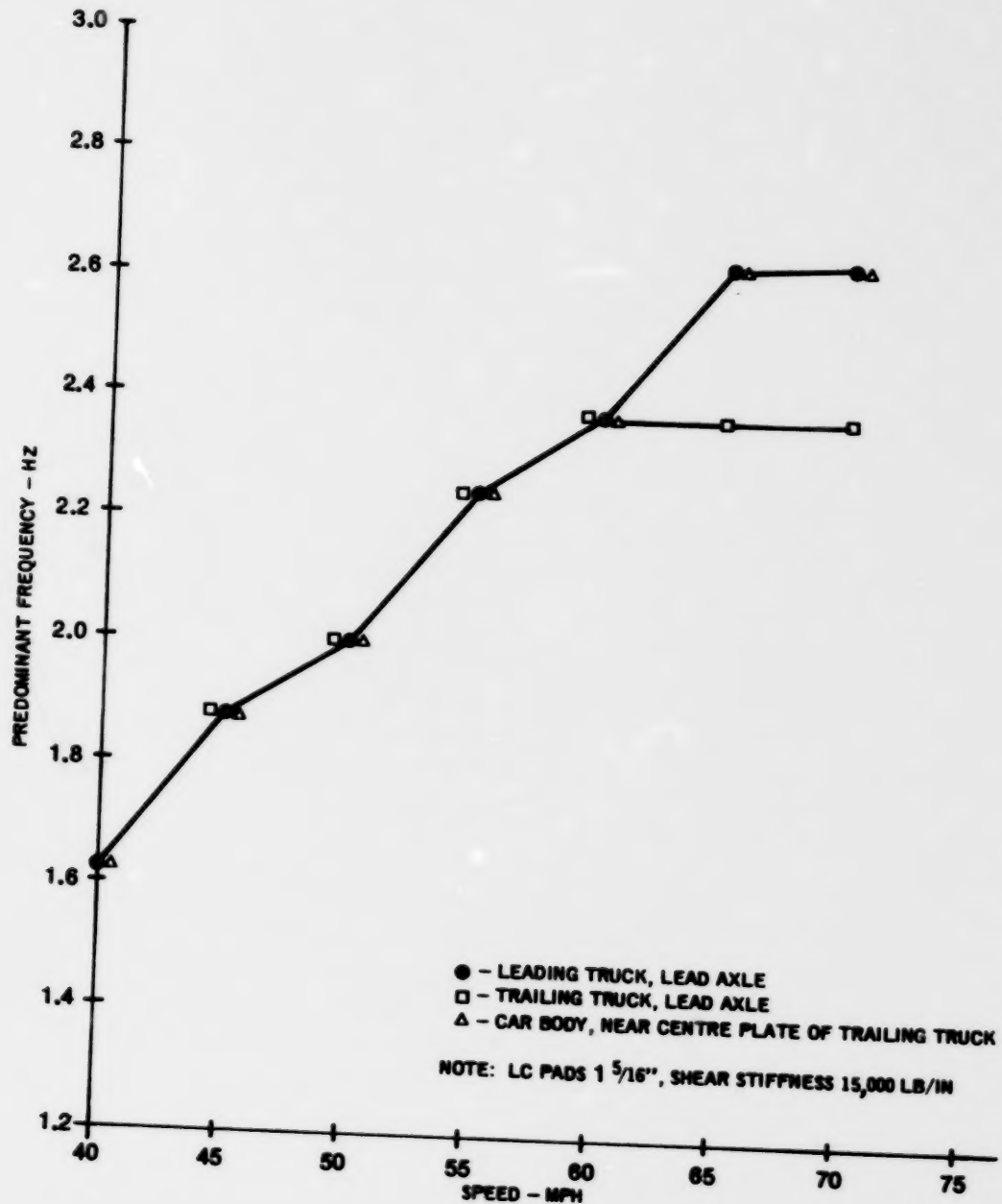


FIG. 9: LATERAL ACCELERATION ON TRAILING TRUCK LEAD AXLE BEARING END CAP VS SPEED
FOR TRUCKS WITH CN "A" PROFILE WHEELS



PREDOMINANT LATERAL WHEELSET AND CARBODY FREQUENCY VERSUS SPEED
FOR THE CONVENTIONAL BARBER S-2 TRUCK
WITH LC PADS AND CN "A" PROFILE WHEELS

FIG. 10

POOR

QUALITY

ORIGINAL

